# 42 Whakapirau

## 42.1 Description and geomorphology

Whakapirau is a small town on the Kaipara Harbour, located on the bank of the Arapaoa River and the entrance to the Pahi River. Figure 42.1 shows the site and its division into four coastal cells for the purpose of assessing coastal erosion hazards. Site photos highlighting key features of the coast at Whakapirau are presented in Figure 42.2.

The site is estuarine with a navigable tidal channel located 100-200 m from the shoreline. The site extends for 900 m alongshore and includes a reclaimed wharf section to the north and a small coastal terrace and beach to the south where the main town is located. The beach section is backed by a natural valley with an underlying geology of Northland Allochthon and the surrounding hills and cliffs flanking the beach are Mahurangi Limestone.

The site is a combination of estuarine beaches, Mahurangi Limestone cliff, reclaimed wharf and estuarine beach with mangrove influence. A narrow tidal flat extends seaward for 60-150 m from the beach toe to the tidal channel. Local wind wave generation at low tide is limited to high tide with a maximum fetch less than 2 km in a southwest direction. Wave height at the coast may also be depth limited by the tidal flat, and it is likely that the coastal processes are tidal dominant. Site observations indicated that the cliff section north of the town was crumbling and unstable. The cliff to the south of town is not included in this assessment. There was little evidence of erosion at the main estuary beach in front of the town.

Beach sediments at Cell A are a mixture of sand and shell. The mid beach is sand dominant, with the sand fraction being of a moderately sorted medium grain size. The foreshore tidal flat is shell and gravel dominant with a sand fraction comprised well sorted, coarse grains. The upper beach is shell dominant with a very small sand component.

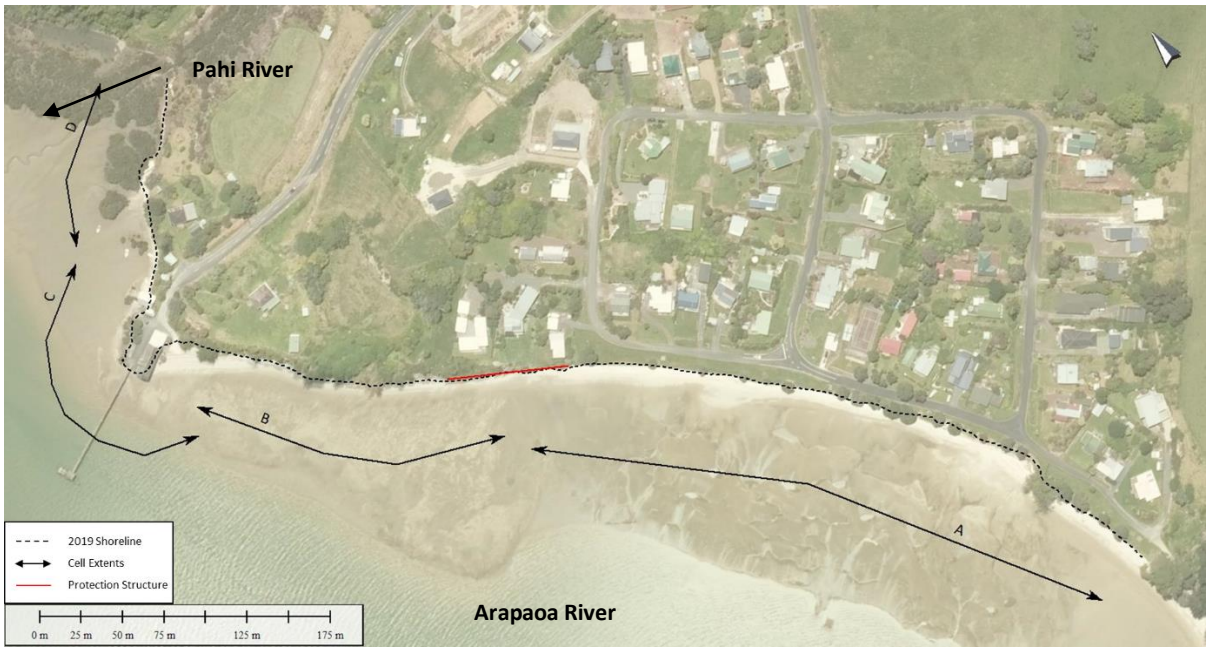



*Figure 42.1: Map showing 2019 shoreline position and cell extents with background aerial imagery from 2014.*

## 42.2 Local considerations

The wharf located towards the northern end of the site is partly sited on reclaimed land and hosts a building that extends into the intertidal zone on piles. At the transition from cliff to beach there are

a few private properties that have rock revetment structures to protect the vegetated terrace from erosion. A series of storm water outflow pipes discharge onto the beach in front of the main town and some discrete sections of the coastal edge are protected by small scale rock revetments to protect a tree, channel or storm water outflow. The section north of the wharf is influenced by a mangrove system and the coastal edge is a mix of natural shoreline terrace and property boundaries walls with no engineered coastal protection.


*Figure 42.2: Photos from Whakapirau site visit on 20/01/2020.*

## 42.3 Component values

The site is split into four cells to account for the different coastal types. The largest cell (A) extends the length of the main estuarine beach (coastal terrace). The grassed coastal terrace is backed by road and no private property is present on the seaward side of the road. The coastal terrace is fronted by a beach with a slope between 0.1 and 0.125, which was used for calculating the shoreline retreat due to sea level rise. This slope is based on the min, mode and max slope between the edge

of vegetation and the tidal flat. Cell B is a coastal cliff of Mahurangi Limestone geology and had a crumbly unstable face during the site visit and a typical toe to crest height of 6–16 m. Higher sections of cliff closer to the wharf had a bare face and steeper slope and lower sections towards the beach were vegetated with a slightly lower slope angle. Mahurangi Limestone material has a relatively gentle stable angle (average 22.5 degrees) and is considered to be highly susceptible to sea level rise. The wharf (Cell C) is considered a modified or reclaimed site but is not protected by modern engineering standards. Cell D extends landward of mangroves along an estuarine coastal terrace that has a mixture of private property walls and grass. This section is influenced by a stream inlet that flows just north of the site.

Analysis of historic shoreline position indicated a general trend of erosion along the coastal terrace coast at Cell A, with an average long-term rate of -0.05 m/yr. Despite the appearance of a crumbling cliff, historic shoreline analysis indicates a reasonably stable cliff at Cell B with an average long-term rage of -0.03 m/yr. Historic shoreline change at the northern estuarine coastal terrace Cell indicated a general erosion trend with an average long-term rate of -0.05 m/yr. A long-term rate of 0 ± 0.1 m/yr was adopted for the reclaimed wharf site as no long-term rates could be derived from historic shorelines.

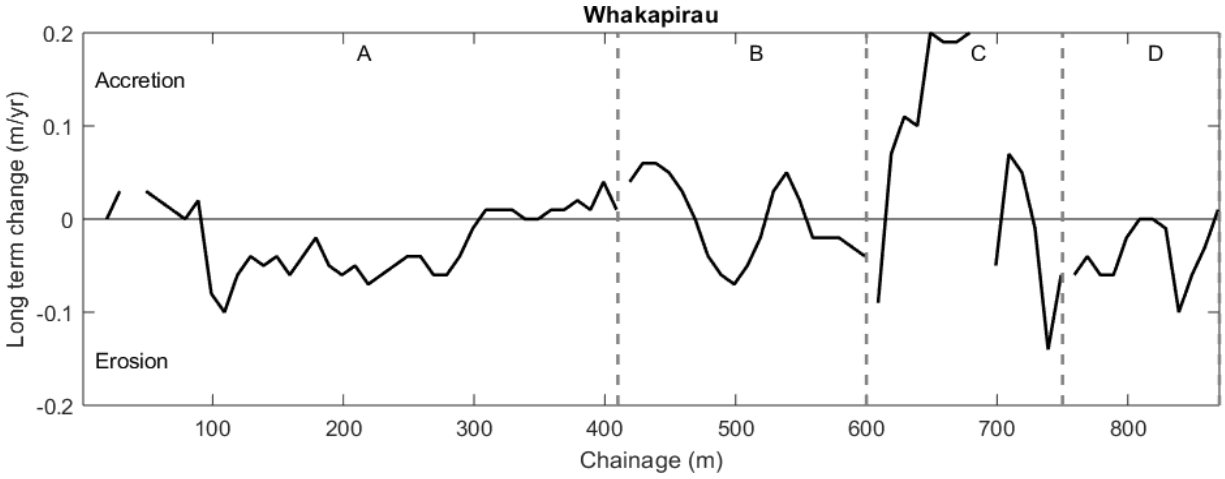



*Figure 42.3: Rate of long-term shoreline change along the site showing each cell.*

**Table 42.1: Component values for Erosion Hazard Assessment**

| Site | | 42. Whakapirau | | | |
|---|---|---|---|---|---|
| Cell | | 42A | 42B[1] | 42C[1] | 42D |
| Cell centre (NZTM) | E | 1711213 | 1710992 | 1710894 | 1710992 |
| | N | 5997753 | 5997973 | 5998109 | 5998205 |
| Chainage, m (from E) | | 0-400 | 410-590 | 600-690 | 750-840 |
| Morphology | | Estuarine coastal terrace | Mahurangi limestone cliff[+] | Reclaimed | Estuarine coastal terrace |
| Short-term (m) | Min | 2 | - | *2* | 2 |
| | Mode | 4 | - | *4* | 4 |
| | Max | 6 | - | *6* | 6 |
| Dune/Cliff elevation (m above toe or scarp) | Min | 1.3 | 1.3 | 1.8 | 0.7 |
| | Mode | 1.9 | 6.3 | 2.3 | 1.3 |
| | Max | 2.6 | 12.3 | 2.9 | 2.4 |
| Stable angle (deg) | Min | 30 | 18.4 | 30 | 30 |
| | Mode | 32 | 22.5 | 32 | 32 |
| | Max | 34 | 26.6 | 34 | 34 |
| Long-term (m) -ve erosion +ve accretion | Min | -0.10 | -0.06 | *-0.10* | -0.10 |
| | Mode | -0.05 | -0.03 | *0.00* | -0.05 |
| | Max | 0.00 | 0.00 | *0.10* | 0.00 |
| Closure slope (beaches) / Cliff response factor | Min | 0.1 | 0.3 | 0.08 | 0.1 |
| | Mode | 0.115 | 0.4 | 0.16 | 0.14 |
| | Max | 0.125 | 0.5 | 0.24 | 0.19 |

[1]CEHZ0 method applies to part of cell, [+]Shoreline partly armoured with engineered coastal protection structure,

**Table 42.2: Adopted sea level rise values (m) based on four scenarios included in MfE (2017) adjusted to 2019 baseline**

| Coastal type | Year | RCP2.6M | RCP4.5M | RCP8.5M | RCP8.5+ |
|---|---|---|---|---|---|
| Consolidated cliff | 2080 | 0.29 | 0.34 | 0.46 | 0.64 |
| | 2130 | 0.52 | 0.66 | 1.09 | 1.41 |
| Unconsolidated beach[1] | 2080 | 0.16 | 0.21 | 0.33 | 0.51 |
| | 2130 | 0.28 | 0.42 | 0.85 | 1.17 |

[1]Adjusted to remove the influence of historic SLR (2.2 mm/year) on long-term rates of shoreline change

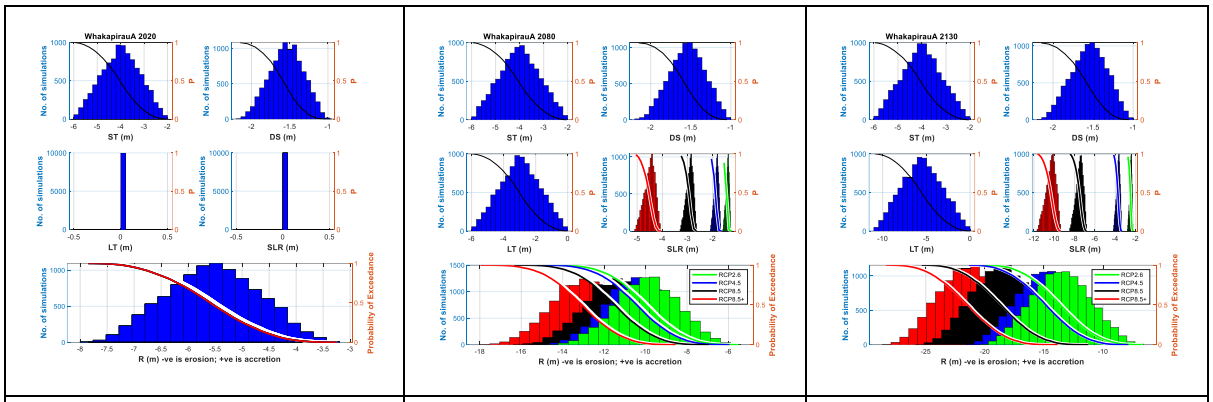
## 42.4 Coastal erosion hazard assessment

Histograms of individual components and resultant CEHZ distances computed using a Monte Carlo technique are shown in Figure 42.4 to Figure 42.6. Coastal Erosion Hazard Zone widths and future shoreline distances are presented within Table 42.3 to Table 42.5 and mapped in Figure 42.7.

CEHZ1 distances range from 10 to 11 m, with Cell C rounded up. CEHZ2 and CEHZ3 distances are rounded to the minimum value of 25 m for terraces.

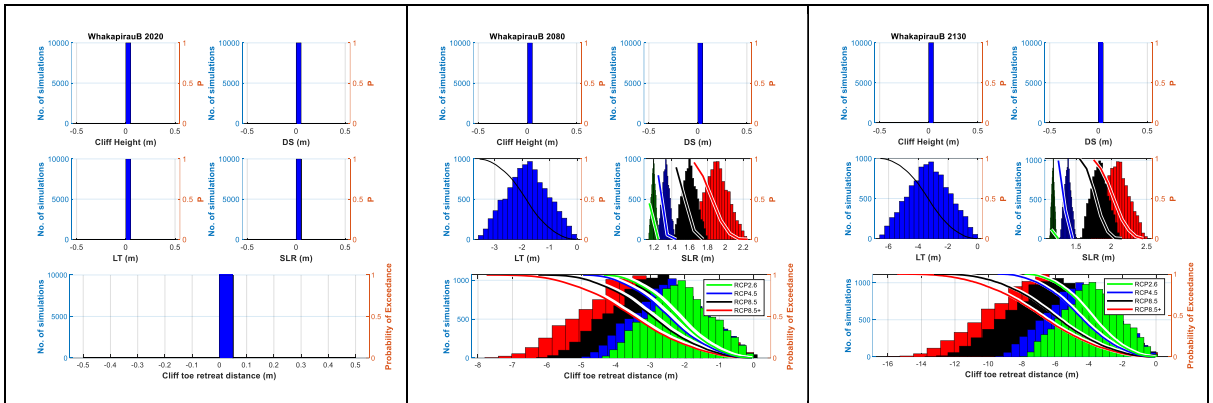
For Cell B, the cliff projection method was adopted and results from the probabilistic analysis below show the toe recession component instead of the total CEHZ distances. The future cliff toe erosion distance to 2080 is 2 m for RCP8.5, 10 m to 2130 for RCP8.5 and 12 m to 2130 for RCP8.5+. The cliff stability component was accounted for by projecting the stable angle from the toe recession location, using LiDAR extracted profiles located in 10 m intervals along the cell. A summary of the resulting total coastal erosion hazard zone is presented in Table 42.6.

Figure 42.8 shows the available historic shorelines for Whakapirau.



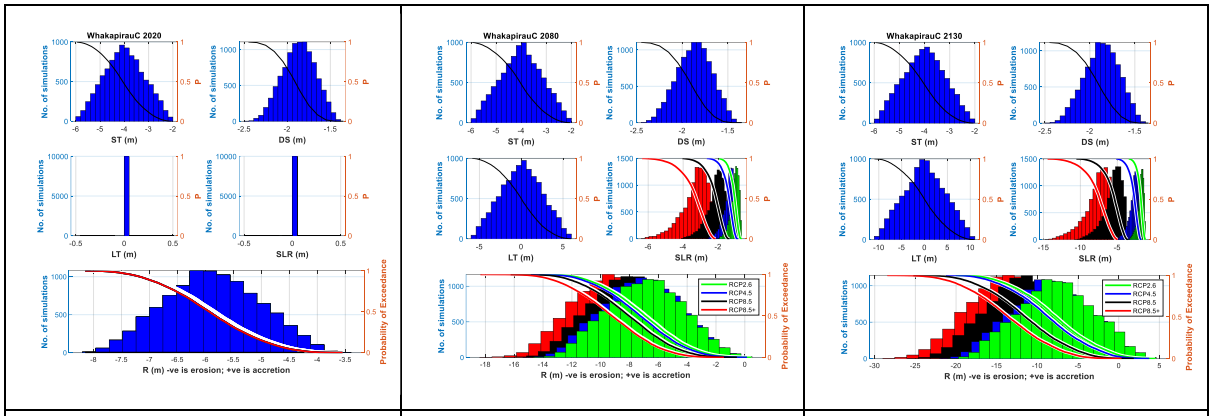

| 2020 | 2080 | 2130 |
|---|---|---|

*Figure 42.4: Histograms of parameter samples and the resultant shoreline distances for 2020, 2080 and 2130 timeframes for cell 42A*




| 2020 | 2080 | 2130 |
|---|---|---|

*Figure 42.5: Histograms of parameter samples and the resultant shoreline distances for 2020, 2080 and 2130 timeframes for cell 42B*




| 2020 | 2080 | 2130 |
|---|---|---|

*Figure 42.6: Histograms of parameter samples and the resultant shoreline distances for 2020, 2080 and 2130 timeframes for cell 42C*

## Table 42.3: Coastal Erosion Hazard Zone Widths (m) Projected for 2020

| Site | | 42. Whakapirau | | | |
|---|---|---|---|---|---|
| | Cell | 42A | 42B* | 42C | 42D |
| Probability of CEHZ (m) Exceedance | Min | -3 | 0 | -4 | -3 |
| | 99% | -4 | 0 | -4 | -3 |
| | 95% | -4 | 0 | -4 | -4 |
| | 90% | -4 | 0 | -5 | -4 |
| | 80% | -5 | 0 | -5 | -4 |
| | 70% | -5 | 0 | -5 | -5 |
| | 66% | -5 | 0 | -6 | -5 |
| | 60% | -5 | 0 | -6 | -5 |
| | 50% | -6 | 0 | -6 | -5 |
| | 40% | -6 | 0 | -6 | -5 |
| | 33% | -6 | 0 | -6 | -6 |
| | 30% | -6 | 0 | -6 | -6 |
| | 20% | -6 | 0 | -7 | -6 |
| | 10% | -7 | 0 | -7 | -6 |
| | 5% | -7 | 0 | -7 | -7 |
| | 1% | -7 | 0 | -8 | -7 |
| | Max | -8 | 0 | -8 | -8 |

*Cliff projection method has been used, so cliff toe position has been tabulated, which has been assumed to be unchanged from the adopted 2019 baseline. Actual CEHZ width will be greater depending on cliff height and stable slope angle.

## Table 42.4: Coastal Erosion Hazard Zone Widths (m) Projected for 2080

| Site | | 42. Whakapirau | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cell | | 42A | | | | 42B | | | | 42C | | | | 42D | | | |
| RCP scenario | | 2.6 | 4.6 | 8.5 | 8.5+ | 2.6 | 4.6 | 8.5 | 8.5+ | 2.6 | 4.6 | 8.5 | 8.5+ | 2.6 | 4.6 | 8.5 | 8.5+ |
| Probability of CEHZ (m) Exceedance | Min | -6 | -6 | -7 | -9 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | -5 | -5 | -6 | -7 |
| | 99% | -7 | -7 | -8 | -10 | 0 | 0 | 0 | 0 | -1 | -2 | -2 | -3 | -6 | -6 | -7 | -8 |
| | 95% | -7 | -8 | -9 | -11 | -1 | -1 | -1 | -1 | -3 | -3 | -4 | -5 | -7 | -7 | -8 | -9 |
| | 90% | -8 | -8 | -9 | -11 | -1 | -1 | -1 | -2 | -3 | -4 | -5 | -6 | -7 | -8 | -9 | -10 |
| | 80% | -9 | -9 | -10 | -12 | -1 | -2 | -2 | -2 | -5 | -5 | -6 | -7 | -8 | -8 | -9 | -10 |
| | 70% | -9 | -10 | -11 | -12 | -2 | -2 | -2 | -3 | -5 | -6 | -7 | -8 | -8 | -9 | -10 | -11 |
| | 66% | -9 | -10 | -11 | -12 | -2 | -2 | -2 | -3 | -6 | -6 | -7 | -8 | -9 | -9 | -10 | -11 |
| | 60% | -10 | -10 | -11 | -13 | -2 | -2 | -3 | -3 | -6 | -6 | -7 | -8 | -9 | -9 | -10 | -11 |
| | 50% | -10 | -10 | -11 | -13 | -2 | -2 | -3 | -3 | -7 | -7 | -8 | -9 | -9 | -10 | -11 | -12 |
| | 40% | -10 | -11 | -12 | -13 | -2 | -3 | -3 | -4 | -8 | -8 | -9 | -10 | -10 | -10 | -11 | -12 |
| | 33% | -11 | -11 | -12 | -14 | -3 | -3 | -3 | -4 | -8 | -8 | -9 | -10 | -10 | -10 | -11 | -12 |
| | 30% | -11 | -11 | -12 | -14 | -3 | -3 | -4 | -4 | -8 | -9 | -9 | -11 | -10 | -10 | -11 | -13 |
| | 20% | -11 | -12 | -13 | -14 | -3 | -3 | -4 | -5 | -9 | -10 | -10 | -12 | -11 | -11 | -12 | -13 |
| | 10% | -12 | -12 | -13 | -15 | -3 | -4 | -4 | -5 | -10 | -11 | -12 | -13 | -11 | -12 | -13 | -14 |
| | 5% | -12 | -13 | -14 | -16 | -4 | -4 | -5 | -6 | -11 | -12 | -12 | -14 | -12 | -12 | -13 | -14 |
| | 1% | -13 | -14 | -15 | -16 | -4 | -4 | -5 | -7 | -12 | -13 | -14 | -15 | -13 | -13 | -14 | -15 |
| | Max | -15 | -15 | -16 | -18 | -4 | -5 | -6 | -8 | -14 | -15 | -16 | -18 | -14 | -14 | -15 | -17 |
| | CEHZ1 | -11 | | | | -2* | | | | -10 | | | | -10 | | | |

*Cliff projection methodology used, so distance to future cliff toe position has been tabulated. Actual CEHZ width will be greater depending on cliff height and stable slope angle.

**Table 42.5: Coastal Erosion Hazard Zone Widths (m) Projected for 2130**

| Site | | 42. Whakapirau | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cell | | 42A | | | | 42B | | | | 42C | | | | 42D | | | |
| RCP scenario | | 2.6 | 4.6 | 8.5 | 8.5+ | 2.6 | 4.6 | 8.5 | 8.5+ | 2.6 | 4.6 | 8.5 | 8.5+ | 2.6 | 4.6 | 8.5 | 8.5+ |
| Probability of CEHZ (m) Exceedance | Min | -7 | -8 | -11 | -14 | 0 | 0 | 0 | 0 | 4 | 4 | 2 | 0 | -5 | -6 | -9 | -11 |
| | 99% | -8 | -10 | -13 | -16 | -1 | -1 | -1 | -1 | 2 | 1 | -1 | -3 | -7 | -8 | -11 | -13 |
| | 95% | -10 | -11 | -15 | -17 | -1 | -1 | -2 | -2 | 0 | -1 | -4 | -6 | -9 | -10 | -13 | -15 |
| | 90% | -10 | -12 | -15 | -18 | -2 | -2 | -3 | -3 | -1 | -2 | -5 | -7 | -9 | -10 | -13 | -16 |
| | 80% | -11 | -13 | -16 | -19 | -2 | -3 | -4 | -4 | -4 | -4 | -7 | -9 | -11 | -12 | -14 | -17 |
| | 70% | -12 | -13 | -17 | -20 | -3 | -4 | -5 | -5 | -5 | -6 | -9 | -11 | -11 | -12 | -15 | -18 |
| | 66% | -12 | -14 | -18 | -20 | -3 | -4 | -5 | -6 | -6 | -7 | -9 | -11 | -12 | -13 | -16 | -18 |
| | 60% | -13 | -14 | -18 | -21 | -3 | -4 | -5 | -6 | -7 | -7 | -10 | -12 | -12 | -13 | -16 | -18 |
| | 50% | -14 | -15 | -19 | -21 | -4 | -5 | -6 | -7 | -8 | -9 | -11 | -14 | -13 | -14 | -17 | -19 |
| | 40% | -14 | -15 | -19 | -22 | -4 | -5 | -7 | -8 | -9 | -10 | -13 | -15 | -13 | -14 | -17 | -20 |
| | 33% | -15 | -16 | -20 | -23 | -5 | -5 | -7 | -8 | -10 | -11 | -14 | -16 | -14 | -15 | -18 | -20 |
| | 30% | -15 | -16 | -20 | -23 | -5 | -6 | -7 | -8 | -10 | -11 | -14 | -16 | -14 | -15 | -18 | -20 |
| | 20% | -16 | -17 | -21 | -24 | -5 | -6 | -8 | -9 | -12 | -13 | -16 | -18 | -15 | -16 | -19 | -21 |
| | 10% | -17 | -18 | -22 | -25 | -6 | -7 | -9 | -11 | -14 | -15 | -18 | -20 | -16 | -17 | -20 | -22 |
| | 5% | -18 | -19 | -23 | -25 | -7 | -8 | -10 | -12 | -15 | -16 | -19 | -22 | -17 | -18 | -21 | -23 |
| | 1% | -19 | -20 | -24 | -27 | -7 | -9 | -12 | -13 | -17 | -18 | -22 | -24 | -18 | -19 | -22 | -25 |
| | Max | -20 | -21 | -25 | -28 | -8 | -10 | -14 | -16 | -20 | -21 | -25 | -28 | -20 | -21 | -25 | -28 |
| | CEHZ2 | -25 | | | | -10* | | | | -25 | | | | -25 | | | |
| | CEHZ3 | -25 | | | | -12* | | | | -25 | | | | -25 | | | |

*Cliff projection methodology used, so distance to future cliff toe position has been tabulated. Actual CEHZ width will be greater depending on cliff height and stable slope angle.

**Table 42.6: Summary of CEHZ distances for cliff cells mapped using cliff projection method**

| | CEHZ1 | | | CEHZ2 | | | CEHZ3 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Cell** | **Min (m)** | **Average (m)** | **Max (m)** | **Min (m)** | **Average (m)** | **Max (m)** | **Min (m)** | **Average (m)** | **Max (m)** |
| **B** | -14 | -27 | -37 | -26 | -42 | -52 | -28 | -44 | -55 |


Notes: Dashed CEHZ indicates greater uncertainty around stream mouths and backshore topography.
Northland 0.4m Rural Aerial Photos (2014-2016).

A4 SCALE 1:3,000

0 0.1 (km)

Tonkin+Taylor
105 Carlton Gore Rd, Newmarket, Auckland
www.tonkintaylor.co.nz

| | | |
|---|---|---|
| DRAWN | JJOU | May.20 |
| CHECKED | | |
| APPROVED | | |
| ARCFILE | 1012360_CEHZ001_v2.mxd | |
| SCALE (AT A4 SIZE) | 1:3,000 | |
| PROJECT No. | 1012360 | |

# NORTHLAND REGIONAL COUNCIL

Coastal Erosion Hazard Assessment
Whakapirau
Site: 42

FIGURE No. Figure 42-7

Rev. 1

Path: P:\1012360\WorkingMaterial\GIS\CEHZ maps\1012360_CEHZ001_v2.mxd Date: 29/05/2020 Time: 6:11:12 am


Notes: Dashed CEHZ indicates greater uncertainty around stream mouths and backshore topography.
Northland 0.4m Rural Aerial Photos (2014-2016).

A4 SCALE 1:3,000

0 0.1 (km)

Tonkin+Taylor
105 Carlton Gore Rd, Newmarket, Auckland
www.tonkintaylor.co.nz

| | | |
|---|---|---|
| DRAWN | JJOU | Jun.20 |
| CHECKED | | |
| APPROVED | | |
| ARCFILE | 1012360_Historicv2.mxd | |
| SCALE (AT A4 SIZE) | 1:3,000 | |
| PROJECT No. | 1012360 | |

# NORTHLAND REGIONAL COUNCIL

Historic Shorelines
Whakapirau
Site: 42

FIGURE No. Figure 42-8

Rev. 1

Path: P:\1012360\WorkingMaterial\GIS\CEHZ maps\1012360_Historicv2.mxd Date: 9/06/2020 Time: 9:24:48 AM